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Do Exemptions Undermine Environmental Policy Support?
An Experimental Stress Test on India's Odd-Even Road Space Rationing Policy

Abstract

Policies sometimes exempt particular categories of regulatees for reasons of equity and political feasibility. Will the non-exempted oppose the policy because they shoulder all the policy costs? We outline an analytic framework for "stress testing" public support among the non-exempted as they are provided with negative information about exemptions and reduced policy effectiveness. Empirically, we study the public support for the odd-even road space rationing policy. Using a survey experiment with 2,182 car owners in Bangalore, we find considerable baseline support for this policy. While the support among the non-exempted erodes when they are told about exemptions, there is no additional erosion when they are told that exemptions reduce policy effectiveness. This suggests that the perception of fairness, not policy efficacy, drive support erosion among the non-exempted. Yet, the policy survives the stress test because the majority of respondents continue to support it, inspite of support erosion among the non-exempted.

Keywords
Urban air pollution, Road space rationing, Survey experiment, policy exemptions, Gender

1. Introduction

Policies and regulations sometimes grant exemptions to particular categories of regulatees for reasons of equity and political feasibility. While exemptions and side payments may help create a political coalition in support of a particular policy, they could also create a backlash from the non-exempted who might resent shouldering the policy costs while others are exempted. The issue of policy exemptions is critical in the context of environmental issues where policy makers seek to persuade actors (usually citizens and firms) to incur private costs to provide for environmental public goods (Hardin, 1968). Anticipating incentives to free ride, authoritative actors, be it governmental or non-governmental actors (Ostrom, 1990), establish policies to mandate, incentivize, or convince regulated actors to incur these costs.

Support for environmental policies and regulations could be undermined when regulatees either disagree over the aims of the policy or resent the perceived asymmetries in the distribution of benefits and costs flowing from the policy. Regulatees may also oppose the policy if they have different capabilities to absorb policy costs. Hence, policy design should take into account the need for equitable (as opposed to equal) burden sharing that may require concessions to some categories of regulatees. Grandfathering clauses that exempt specific actors (temporarily or permanently) from new environmental regulations are one example. Suppose a new regulation requires power plants to substantially lower their pollution levels (Cramton and Kerr, 2002). Might this new rule affect all firms equitably? Consider two actors: an existing firm burdened with sunk cost in existing plant and machinery versus a new entrant with no such investments. It would be less costly for new entrants to meet the regulatory requirements by installing state-of-the art technology. In contrast, for the firm with a relatively old plant, retrofitting might be

unduly expensive. Hence, regulators may grandfather old plants altogether, grant them extra time to retrofit, or sometimes even provide financial support.

Yet, policy exemptions pose political challenges as well. Some regulatees might view exemptions as being granted for "political reasons," and not to address any substantive inequity. They may also be concerned that exemptions could reduce the effectiveness of the policy. In that situation, non-exempted regulatees might feel that their "sacrifice" will be reduced in value or even in vain. This may motivate them to mount an opposition to derail the policy's adoption. A crucial challenge for policymakers is thus to assess how an envisaged policy is viewed by those sub-populations with most incentives to mount an opposition to it. We call such assessment a "policy stress test."

To systematically examine how policy exemptions influence policy support, we outline an analytic framework. Two insights motivate this framework. First, public support for a policy could vary depending on the type of information about policy design provided to regulatees. For example, when information about policy exemptions and how they undermine policy effectiveness is provided, support for the policy might wane, particularly among the non-exempted actors. The intuition is that as bounded rational actors, stakeholders' (in our empirical case, individual car owners) support for the policy at hand is based on the information they receive. If the additional information portrays the policy in a negative light, support might diminish. Consequently, the robustness of public support, which is essential for most environmental policies, could be assessed via stress testing in which respondents receive different levels of negative information about the policy.

Second, policies are adopted (or not adopted) if a sufficient political coalition can be mobilized in favor (or in opposition) of the policy. Groups that bear concentrated costs have

strong incentives to mobilize against the policy. Consequently, the second stress test should focus on assessing the level of policy support among actors on whom policy costs are concentrated. Here as well, the robustness of their support (or opposition) could be assessed as regulatees receive different levels of negative information about the policy. Our framework thus provides a diagnostic tool to assess the robustness of public policy support as negative features of the respective policy are highlighted.

Following this framework, we first test hypotheses about overall public support for a given policy (Hypothesis 1) and the support when regulatees are provided with information about ancillary benefits of the policy (Hypothesis 2). We then initiate the stress test by comparing support among exempted and non-exempted regulatees (Hypothesis 3). Because there might be preference heterogeneity within the non-exempted, we then compare policy support in two subgroups of the non-exempted. The first subgroup of interest is those who intensively use cars for their transportation needs and therefore face higher costs imposed by the policy. The second subgroup includes those who perceive the air pollution problem to be severe and those with a family member with respiratory problems, both of which should perceive high benefits from the proposed policy (Hypothesis 4). The insights thus gained can help policy-makers to target policy messages more specifically at different constituencies. Among the non-exempted, we further explore levels of policy support when negative information is provided that suggests that exemptions reduce policy effectiveness (Hypothesis 5). As in Hypothesis 3, we examine policy support in the two subgroups within the non-exempted regulatees.

Our analytical approach could be useful for studying policy support in light of policy exemptions in a wide range of issue areas and countries. Policy exemptions are a tool to address equity issues as well as to construct political support. Yet, they can also raise concerns about

"policy capture" whereby non-meritorious groups are exempted, and also about reduced policy effectiveness.

Empirically, we focus on a road space rationing policy known as the "odd-even" rule. In India, on which we will concentrate, this policy was first introduced in Delhi, and we assess public support for it, should it be extended to additional cities. Under the odd-even rule, private cars with odd registration numbers were allowed on the road on Mondays, Wednesdays and Fridays, while the ones with even numbers were allowed on Tuesdays, Thursdays, and Saturdays. No restrictions apply on Sundays. Car owners can thus use their car on three out of six days of the working week. On other days when they cannot use their car, they need to find alternative means of transportation to get to office, drive children to school, visit friends and relatives, and go to the market. Thus, the odd-even rule imposes very tangible private costs on car owners while creating a public benefit of reduced air pollution and congestion.

Thus far, women drivers and two-wheelers were exempted from this policy, with much of the public debate focused on the former exemption. We are primarily interested in assessing policy support among (non-exempted) male drivers in response to various information treatments. Based on a survey embedded experiment with 2,182 randomly sampled car owners in Bangalore, we find considerable public support for costly road space rationing even among the non-exempted car owners. Importantly, policy support among the non-exempted did not erode *even after* they were told that exemptions reduced policy effectiveness. These findings suggest that policy exemptions may not invite backlash even among those with strong incentives to do so. Our results thus suggest that policy-makers in India are on relatively safe grounds in terms of public support when expanding road space rationing policies, along with gender-based exemptions, from Delhi to other parts of the country.

The remainder of the paper proceeds as follows. In section 2, we describe the empirical context of the odd even rule. In section 3, we outline our analytic framework and develop several hypotheses. In section 4, we describe the study design. We then present the results and findings in section 5 and conclude in section 6.

2. Urban Air Pollution and Road Space Rationing in India

Urban air pollution is a major public health problem worldwide, particularly in developing countries. It stems from a range of sources, including households (notably, the use of wood, coal or dung for cooking or heating), electricity production, industry, construction dust, farming (e.g. burning fields after harvests in rural areas around urban centers), and transportation. Because the ill effects of air pollution are highly visible, there is often strong political pressure to address the problem. Environmental policies targeting motor vehicles are politically attractive in this regard, because vehicles and their emissions are highly visible and vehicles are responsible also for other problems, such as traffic congestion, noise, and accidents (Bernauer and Koubi, 2009; Cao and Prakash, 2010).

This focus is, however, justifiable because vehicles are a major contributor to urban air pollution across the world. There are 1.2 billion vehicles in the world and this number is expected to reach 2 billion by 2035.[1] Automobiles are important means of transportation. While they account for less than one-third of travel distance, they contribute 73 percent to urban air pollution. Over the years, policy-makers have battled the "traffic problem" in a variety of ways. They have created toll roads, introduced congestion pricing (Evans, 1992; Giuliano, 1994;

[1] http://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

Schuitema et al., 2010), reserved lanes for high occupancy vehicles (Dahlgren, 1998), banned specific types of vehicles during peak hours (Holguín-Veras et al., 2005), prohibited the use of diesel (Ben-Weiss, 2008), and restricted the use of personal automobiles based on license plate numbers. In 1990, Singapore went even a step further than most other countries by imposing an upper bound on the number of personal vehicles and auctioning the right to own a vehicle to the highest bidder (Chin and Smith, 1997). Along with restricting unfettered and free access vehicles have to public roads, cities have also sought to increase the cost of complementary products or services, such as roadside or public parking (Bonsall and Young, 2009), and to reduce the cost of substitutes, notably public transportation (Calthrop and Proost, 1998; Chidambaram et al., 2014).

Air pollution problems are particularly severe in India, the empirical focus of this paper. A recent study notes that outdoor air pollution contributes to half a million premature deaths each year in India (Ghude et al., 2016). Indian cities account for 7 of the 15 most polluted cities worldwide in terms of PM 2.5.[2] New Delhi, in particular, is notorious for poor air quality. In response to a public interest litigation (MC Mehta *v.* Union of India), in 1998 the Supreme Court of India mandated that all city buses must be converted from diesel fuel to compressed natural gas (CNG) by March 2001. Auto-rickshaws, initially exempted, were later brought under the same rule. Yet, Delhi's air pollution has worsened. The same applies to other major cities of the country, including Bangalore, on which we will concentrate in this paper. While air quality is subject to seasonal fluctuations, by some accounts, during 2016-2017 Bangalore exceeded

[2] http://www.businessinsider.com/the-cities-with-the-worlds-worst-air-pollution-who-2016-5/#15-kanpur-india-115-gm3-of-pm-25-1

national ambient air quality standards for PM 10 and PM 2.5[3] and ranks behind Delhi as the city with the most acute air pollution problems. [4]

Air pollution from vehicles can be addressed through a variety of mechanisms. Why did the Delhi government introduce the odd-even rule and why did it exempt certain categories of regulatees? In 2015, the newly elected Aam Aadmi Party (AAP) government of the national capital territory (NCT) of Delhi announced that it would conduct a policy experiment to reduce air pollution, based on the odd even rule, during January 1-15, 2016, and again during April 1-15, 2016. As noted above, under the odd-even rule, private cars with odd registration numbers were allowed on the road on Mondays, Wednesdays and Fridays, while the ones with even numbers were allowed on Tuesdays, Thursdays, and Saturdays (no restrictions on Sundays).

Why the odd-even rule? Why not some other policy to tackle Delhi's severe air pollution problems? Two issues are critical here. First, Delhi's AAP government tends to espouse populist pro-poor policies. While car ownership has vastly increased in Delhi in the last decade, cars are still an elite item (Goel et al., 2015). Second, given the traffic situation in Delhi, something that is better experienced than described, complex policies such as congestion pricing pose almost unsolvable enforcement (and communication) challenges. It is not surprising, therefore, that the AAP government favored a policy that posed fewer enforcement problems and imposed targeted costs on the more affluent parts of society: the car owning population. Furthermore, the legitimacy of the policy was enhanced because cities in other parts of world have used the odd-even rule as well (Wang et al., 2014; Liu et al., 2016; Jia et al., 2017).

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[3] http://bangaloremirror.indiatimes.com/bangalore/others/air-pollution-in-city-leads-to-spike-in-lung-diseases/articleshow/59852638.cms

[4] http://www.dnaindia.com/locality/bengaluru-central/bangalore-ranks-second-list-cities-highest-air-pollution-levels-58926

Policy diffusion to new jurisdictions is often constrained by path dependencies. One reason is that policy design features in the "test market" create expectations about the distribution of benefits and costs. In our case, we are most interested in the issue of how exemptions influence political support among the non-exempted, and whether support levels change as additional information about policy features is provided to regulatees. We thus explore support for (or opposition to) policy exemptions if the policy were to be expanded to other locations. The odd-even rule tested in Delhi granted exemptions, the most prominent ones were women car drivers and two-wheelers. Two-wheelers were exempted for a variety of reasons, including that these are commonly used by the less affluent, and because of their very large number (5.6 million) restrictions on their use would overwhelm other modes of transportation[5]. Women were exempted in the light of difficulties they might face in using public transportation. Highly publicized instances of sexual assaults on women using public transportation (specifically, the Nirbhay[6] case) made this a highly salient political issue[7] not only in Delhi but all over India.

Importantly, the odd-even rule was heavily criticized and legally contested because of the exemptions it provided. In response to a public interest petition, the Delhi High Court asked the Delhi government to explain why exemptions were granted to women and two wheelers.[8] Some women celebrities, including prominent journalist Barkha Dutt, criticized the exemptions. She

[5] http://www.oneindia.com/india/odd-even-rule-explain-exemption-women-two-wheelers-hc-delh-1969443.html

[6] http://www.newyorker.com/news/news-desk/after-a-rape-and-murder-fury-in-delhi

[7] http://www.india.com/news/cities/supreme-court-says-wont-cancel-odd-even-rule-860840/

[8] http://www.oneindia.com/india/odd-even-rule-explain-exemption-women-two-wheelers-hc-delh-1969443.html

tweeted:[9] "@BDUTT As a single woman, I dont want exemption from #OddEvenFormula- think women who CAN must stand up & say so. Exemptions make me uncomfortable."

As is obvious from fierce debates over the policy in the media and policy circles, public opinion is crucial in this case, which is why studying the impact of exemptions on policy support is essential. While there is very little systematic public opinion data[10], our own reading of the news media suggests that the odd-even rule was unpopular among Delhi citizens prior to its introduction.[11] Many criticized the inconvenience it would cause and also believed that it would fail because it would be difficult to enforce and easy to circumvent: in fact, one poll suggested that 69% believed that this policy could not be enforced.[12] In particular, there was opposition to exemptions, an issue that the Delhi High Court also became involved in. Yet, once the policy experiment was over (both after the first iteration in January and the second one in April 2016), public support for the policy appeared to have increased substantially (Schuitema et al., 2010*)*, though systematic before-after comparison is not feasible due to lacking commensurable survey data.[13] While in December 2015, 69% of the respondents believed that this policy would fail,[14] in

[9] https://www.quora.com/AAP-government-exempted-women-drivers-on-odd-even-car-policy-Is-this-first-step-towards-gender-equality-and-women-empowerment-in-Delhi

[10] http://timesofindia.indiatimes.com/city/delhi/TOI-poll-53-say-Delhis-odd-even-car-plan-is-a-bad-idea/articleshow/50053722.cms

[11] http://www.financialexpress.com/economy/odd-even-formula-cars-not-to-blame-for-delhi-pollution/183759/

[12] http://www.dnaindia.com/india/report-69-of-delhi-believes-odd-even-car-formula-cannot-be-implemented-survey-2157506

[13] After the January 2016 (and again in April 2016) policy experiment in Delhi, there were spates of claims and counter claims relating to its effectiveness (Pavani et al., 2016; Goyal and Gandhi, 2016; Mohan et al., 2017). Greenstone et al. (2015), probably the most prominent study on this issue, compare the PM2.5 concentrations in New Delhi before and after the policy experiment, and both within and in four areas in the neighboring states outside Delhi where this policy was not implemented. The authors find that the odd-even policy reduced PM2.5 levels between 10-13% on daily average, and an additional 10% during office hours, 8 am-8 pm. By some account, including the Greenstone et al. (2015) study, the

February 2016, 78% agreed[15] that it reduced pollution.[16] New Delhi's experience has sparked off discussions about the feasibility of making it permanent in New Delhi and extending it to other cities in India, which also suffer from extremely high pollution levels.[17] We thus decided to examine public support for introducing the odd-even rule *outside* Delhi, based on a survey embedded experiment with 2,182 car owners in Bangalore,[18] a thriving metropolitan city with acute air pollution problems where introducing the odd-even rule has been considered.[19]

3. Analytic Framework and Hypotheses

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reductions in peak time pollution amounted to around 20%. Additional benefits included reduced congestion, and building a feeling of solidarity among Delhi residents about jointly pursuing a common task. It seemed that Delhi citizens relied more on public transportation: an estimated 5.3 million people commuted by bus per day during the period when the odd-even rule was in place (4.7 million in previous weeks). Delhi Metro's daily ridership rose from 2.6 million to 2.75 million during the policy experiment.

[14] http://www.dnaindia.com/india/report-69-of-delhi-believes-odd-even-car-formula-cannot-be-implemented-survey-2157506

[15] http://www.abplive.in/india-news/abp-news-nielsen-opinion-poll-arvind-kejriwal-to-form-government-in-delhi-with-48-seats-people-back-his-schemes-289395

[16] A recent study suggests that air pollution actually increased during the policy experiment phase because citizens switched to exempted vehicles such as two and three wheelers which tend to be more polluting (Chandra et al., 2018).

[17] See, for example, Mumbai: http://www.automotiveml.com/blog/mumbai-traffic-authorities-implement-delhi%E2%80%99s-odd-even-rule-navi-mumbai; Chennai: http://timesofindia.indiatimes.com/city/chennai/Odd-even-scheme-definitely-feasible-in-city-Experts/articleshow/50545204.cms; Bangalore: http://www.thehindu.com/news/cities/bangalore/are-you-ready-for-oddeven-formula/article7964066.ece; Hyderabad: http://www.deccanchronicle.com/151209/nation-current-affairs/article/city-test-odds-evens

[18] http://www.thehindu.com/news/cities/bangalore/govt-considering-oddeven-formula-for-cars-in-city/article8047052.ece; http://bangaloremirror.indiatimes.com/bangalore/cover-story/Not-odd-Even-city-is-looking-at-Delhi-plan/articleshow/50068324.cms

[19] http://www.business-standard.com/article/current-affairs/a-bengaluru-neighbourhood-s-toxic-air-portends-india-s-future-115041100200_1.html

Scholars of "mass politics" tend to focus on the role of mass organizations in initiating and sustaining political action (Gabel, 1998; Mettler and Soss, 2004). In this literature, issues of collective action challenges in interest group mobilization, and the political and resource mobilization strategies of advocacy groups become important. Our focus is on mass policies that directly affect a large number but not on the strategies or structures of advocacy groups that support or oppose such policies. For example, policies that mandate motorcyclists to wear helmets directly affect the behavior of a large number of motorcyclists (Vogel, 1990). But the support for or opposition to such policies are not necessarily mediated through mass organization. Because mass policies intrusively influence the lives of a large number of citizens, understanding the public response to them is crucial to understand the policy dynamics, including why they are adopted or not adopted. Another way to think about this issue is that some policies that directly influence citizens might be mediated through interest groups or political parties (Kitschlet, 2000), while in other cases, policy makers are directly communicating with mass publics. Social media, particularly Twitter, has certainly encouraged such direct politics where political actors directly communicate with mass publics without the intermediation of interest groups (Grant et al., 2010).

The odd-even rule is an example of a mass policy that directly affects the behaviors (transportation options via the permission to use their car) of a large number of citizens or regulatees, and opposition/support to this policy is not mediated by interest groups. Thus, the role of public opinion is crucial in such policy arenas because it provides guidance to policy makers and thus influences the likelihood of policy adoption and eventual implementation.

To guide our empirical enquiry, we outline a five-step analytic framework for studying how policy design (policy exemptions in our case) might cause policy backlash and therefore

undermine policy support among regulatees. The insight motivating this framework is that policymakers need to anticipate reactions to a proposed policy from regulatees with heterogeneous preference. We suggest that for mass policies the likelihood of their adoption and successful implementation depends not only on how well they are perceived overall, but also on how the subpopulations that are adversely affected respond to them. Sometimes policy adoption is derailed because those who are potentially hurt by the policy are motivated to oppose it, especially if the policy imposes concentrated costs on them, while the policy beneficiaries are not expressive or vocal in their support. While policymakers are advised to explore the possibility of building a winning coalition, we suggest that policy makers should also assess the policy support (opposition) among those subpopulations with the greatest incentives to oppose the policy[20]. We view this as a "stress test". The idea is to study whether the graduated provision of negative information erodes support for the policy among the subgroup with the strongest incentive to oppose the policy.

Based on this insight, we propose a five-step policy "stress test". In step 1, we examine support levels for a policy in response to the description of the overall policy approach, without providing information about policy features that impose differentiated costs or benefits across regulatees, or undermine policy effectiveness. If at the aggregate level the policy has scant support, the likelihood of its adoption and effective implementation is small. This could be viewed as the baseline support level.

In step 2, we further examine baseline support by treating all study participants with information about positive spillover (or ancillary) effects of the policy. This information is about non-excludable public benefits as opposed to excludable private benefits flowing from the

[20] Because we are examining public opinion, and not interest group maneuvering, we are not focusing on veto points and other institutional obstacles to policy adoption.

policy. We provide information to evoke respondents' sense of public responsibility (such as helping to solve a pressing problem) or their national pride. Empirically, we highlight two types of ancillary benefits of the odd-even rule: contributing to climate change mitigation (public responsibility) and strengthening Indian's global leadership in climate change mitigation efforts (national pride).

In step 3, we examine support among actors/regulatees with different opportunity costs of complying with the policy. In our empirical application, we provide information about policy exemptions for female drivers. We are interested in assessing how this information influences the level of support among non-exempted male drivers who bear the full policy cost, whereas the exempted female drivers do not. Additionally, we also compare support levels between two other subgroups relevant to the exemptions issue, exempted drivers of two wheelers and the non-exempted car drivers, though we pay less attention to this distinction because it has attracted much less public debate.

In step 4, we focus on non-exempted male drivers only. This is due to two reasons. First, much of the controversy over exemptions pertains to gender-based exemptions. Second, we have an insufficient sample size to examine subgroups within the non-exempted for two wheeler owners. Thus, in step 4, our objective is to assess whether policy support varies within subgroups among the non-exempted male drivers. In particular, we focus on subgroups that face particularly high costs of policy adoption and/or a subgroup that has (in our specific case, ironically) an offsetting reason to favor the policy. Insights from this analysis can allow policy makers to target their policy messages more carefully at different constituencies even among the non-exempted.

The first subgroup of interest is those who intensively use cars for their transportation needs and therefore face higher costs imposed by the policy. Arguably, the intensity of opposition to exemptions could be particularly high in this subgroup, as opposed to the rest of the non-exempted. The second subgroup includes those who perceive the air pollution problem to be severe and those with a family member with respiratory problems, both of which should perceive high benefits from the policy. Both of these groups will probably like to see a reduction in air pollution, but they might resent policy exemptions and the fact they have to shoulder the policy costs. Yet, their policy opposition may be lower because they feel that some policy action is better than none. This is akin to Olson's (1965) "privileged group" where some actors are willing to incur the cost of collective action because they expect to receive high levels of benefits from it. Thus, step 4 allows us to delve deeper into the preferences of different subgroups amongst the non-exempted, thereby providing a more nuanced understanding of potential opposition to the policy.

In step 5, we increase the "stress" on the policy by highlighting how policy exemptions reduce policy effectiveness. In doing so, we put additional emphasis on unfavorable aspects of the policy design, and examine how the non-exempted group responds to this information. As in step 4, we recognize that there might be heterogeneity in preferences among the non-exempted. We therefore assess whether the provision of negative information about reduced policy effectiveness due to exemptions erodes policy support within the two subgroups. Arguably, support among those using their vehicle intensively might erode (compared to the previous stage when this information was not provided) because they might feel that the value of their sacrifice is undermined or even wasted. Among the other subgroups – those who believe that the problem is severe or those with a family member with respiratory problems—we expect some frustration

with exemptions. Perhaps, information on the exemption-effectiveness link will erode their support for the policy as well compared to the previous stage when this information was not provided. Our analytic framework is depicted in Figure 1.

Figure 1 here

Hypotheses on Policy Support

Substantively, we examine support for a road space rationing policy in India that seeks to reduce urban air pollution. Based on our analytic framework, we propose several hypotheses. While both female drivers and two-wheelers were exempted from this policy, the main controversy over exemptions emerged in the context of women drivers. Hence, we focus primarily on policy support among women car drivers (exempted from the rule) and male car drivers (not exempted from the rule), although we also test a subset of hypotheses for two-wheelers.

We begin with an assessment of the baseline of support in two ways. Without some base level of overall public support, the chances of policy adoption and effective implementation are slim. Although prior to its introduction in Delhi the odd-even rule was unpopular, it appears to have gained in popularity once it was introduced. This also led to demands that it be extended to other cities in India. Given intense air pollution problems, people in Bangalore are probably influenced by the "warm glow" of the odd-even rule in Delhi. Hence, as the first step, we provide all respondents with basic information about the odd even rule without focusing on policy exemptions.

Hypothesis 1: The Odd-Even Rule presented in general terms will receive a high level of support among all respondents, both male (non-exempted) and female (exempted).

Second, we bring in the issue of ancillary benefits as drivers of baseline support. While the odd-even rule was aimed at improving local air quality, it also has global implications. We therefore focus on a positive feature of the policy as reflected in spillover effects. We treat respondents with new information about how the odd-even rule could help in mitigating climate change, a pressing problem that gets a lot of media attention in metropolitan India, and on how this rule could help India demonstrate global leadership, which speaks to rising nationalism in India. Therefore, we propose:

Hypothesis 2a: Information on climate change mitigation ancillary benefits of the odd-even rule is likely to enhance support for the odd-even rule among all respondents.

Hypothesis 2b: Information on how the odd-even rule will enhance India's global leadership in climate change mitigation will enhance support for the odd-even rule among all respondents.

Having examined overall levels of support, we begin with the policy stress test. While the policy is likely to receive a high level of support when it is described in general terms, support might erode among the non-exempted when they are provided with information about policy features that concentrate costs on them. Hence, we propose the first "stress test." The logic is that those

bearing most of the policy burden are likely to believe that either the exemptions are unfair, or resent bearing the disproportionate burden for this policy. While not central to our study, we also propose a hypothesis regarding exemptions to two wheelers. Therefore, we propose:

Hypothesis 3a: Additional information about policy exemptions reduces support among the non-exempted (male car owners) relative to the exempted (women car owners).

Hypothesis 3b: Additional information about policy exemptions reduces support among the non-exempted (car owners) relative to the exempted (owners of two wheelers

We recognize that there might be heterogeneity in preferences among the non-exempted. For example, even the non-exempted might have another reason such as health issues to support the policy, no matter how imperfect. As we noted previously, given the sample size issue, we limit this hypothesis to the gender dimension of policy exemptions. Therefore we propose:

Hypothesis 4: When provided with additional information about policy exemptions, within the non-exempted (male car owners), policy support among the subgroup with higher intensity of car use is lower than support among the subgroup that views air quality problems as severe and the subgroup with family members experiencing respiratory problems.

In step 5, we increase the stress on the policy by highlighting how its specific design feature of policy exemptions reduces policy effectiveness. The logic is that those bearing the burden of

policy implementation may feel abused when they realize that their sacrifices could be undermined by behaviors of the non-exempted. Yet, as the previous step, the level of erosion will vary among different subgroups. Therefore, we propose:

Hypothesis 5a: Policy support among the non-exempted (male car owners) erodes when they are told that exemptions reduce policy effectiveness.

Hypothesis 5b: Within the non-exempted (male car owners), policy support among the subgroup with higher intensity of car use erodes more than among the subgroup that views air quality problems as severe and the subgroup with family members experiencing respiratory problems.

4. Study Design

To test the above hypotheses, we implemented a survey embedded experiment with 2182 car owners in Bangalore from 24 January – 26 February 2017. Two pilot tests with N=200 and N=400 respectively were carried out in December 2017 to assess and improve the survey instrument (see also below). The survey languages were English and Kannada, the local language (participants were free to choose).[21] To facilitate the interviewing of women, the team included two female interviewers. We oversampled slightly on women (resulting in 19% of the sample) to obtain sufficient statistical power for analyzing whether those exempted exhibit stronger policy support, with interviewers selecting women car owners in a household where

[21] The survey experiment was designed by the authors. The data collection was undertaken in face-to-face form by Across Research & Communication Pvt. Ltd. (headed by Ved Prakash Sharma, 274-D Beldari Tola Anshik, Mahmoodabad Sitapur, Uttar Pradesh, India).

both a man and a woman owned a car. Because we wanted to compare exempted and non-exempted car owners, our sample includes car owners who may or may not own two wheelers (male and female), but not non-car owners owning or not owning two wheelers. This restricts our comparison of exempted and non-exempted individuals to gender based exemptions.

In the Online Appendix, we show the interview locations across the city and provide the balance table. Out of 198 wards in Bangalore, 30 wards were randomly selected. They differ substantially in terms of demographics and average income levels. The average age of respondents was 37.3 (min=18, max=80). 36.8% had an education level less than Bachelor, 63.2% a Bachelor degree, similar or higher. Also, driving by women is fairly common: 77% of women respondents note that they have used their car in the past four weeks. The average interview duration was 12.45 minutes.

The survey also included standard socio-demographics, such as an individual's sex, age, education, and number of children. We also account for an individuals' automobile use, including items on whether they own a car or motorcycle and how many hours in a week they use these vehicles. Finally, we included items relating to health and pollution concerns, capturing individuals' beliefs about the severity of air pollution as well as whether they or anyone in their family suffered from related health issues (see the online appendix for the questionnaire).

We assessed public support for (opposition to) the odd-even policy, the dependent variable in the analysis, via the following question: "Would you oppose or support introducing the odd-even rule for private cars in Bangalore?" Scale: Strongly oppose, Oppose, Neither oppose nor support, Support, Strongly support.

For the experiment, participants were randomly assigned to a control (placebo) or treatment group. The information on what the odd-even rule is, which all groups received, and

then the treatment conditions, which only those in the respective treatment group received, consisted of text and illustrations that were handed out to survey participants in hard-copy form. The rest of the survey was completed on tablets. The hard-copy format for the treatment conditions was chosen based on the results of the two pilot tests, where many participants expressed a preference for this approach in the most demanding (experimental) part of the survey.

As illustrated in Figure 2, all participants received one (hard-copy) page with basic information on what the odd-even rule is (without any information on exemptions and policy effectiveness). We preferred this conceptualization of the control (baseline) group over not giving the control group any information on what the odd-even rule is. This approach creates a common baseline for all groups, that is, basic information about the design and objectives of the odd-even rule), and then allows us to examine the effects of additionally treating randomly assigned participants with information on exemptions and other aspects of the odd-even rule.

Insert Figure 2 here

After receiving basic, neutrally worded information on the odd-even rule, the control group then received what can be considered a placebo treatment, stating that: “This odd-even policy has been widely discussed in the media, by politicians, and by transportation experts. The crucial issues are who should be subject to the odd-even policy, whether the policy is effective, and whether it makes sense to put this burden on car owners in order to reduce air pollution.” We prefer this placebo approach because it creates more homogenous conditions across groups in

terms of survey length. The treatment groups received the following information, shown in summary form in Table 1 below.

Insert Table 1 here

To assess whether participants understood the information they received, all participants were then asked to respond to questions that revealed their comprehension of the odd-even rule. Participants assigned to the treatment groups were asked to respond to an additional item assessing whether they understood the treatment. Respondents who provided a wrong answer to any one of the comprehension checks were asked to look at the hard-copy handouts once again. They were then asked to continue the survey (without having to respond to the comprehension checks again). This approach follows an "intention to treat" logic, which we think is more realistic than forcing participants to re-read the treatment again and again until they provided correct answers to comprehension check items.

Figure 3 shows summary information on prior knowledge of the odd-even policy (items before the experimental part was administered). It shows that the large majority of survey participants in Bangalore had heard of the odd-even policy in Delhi, and that they were able to correctly answer all or most of five questions about the basic features of this policy.

Insert Figure 3 here

For the results, we focus on two issues: (1) policy support estimated using Ordinary Least Squares regression (OLS) and (2) a quantitative measure we develop to assess of whether a

policy passes or fails the stress test. Our explicit stress test captures the idea that whether a majority supports or opposes a given policy is of importance. It is possible that a policy loses overall support due to intense opposition from specific subgroup. Thus, with the provision of negative information to the non-exempted stress, we can assess not only the erosion of support among this group but also how this affects overall support for the policy.

Therefore, we estimate, using an ordered logit, the ratio of individuals who support the odd-even policy relative to those who oppose the odd-even policy, given individual characteristics (e.g. treatment status and whether they are exempt or not). We therefore define a failure of the stress test to be the situation where a policy that previously had more support than opposition (ratio > 1) subsequently has more opposition than support after the stress test (ratio < 1). Given this definition, significant negative treatment effects are a necessary but not sufficient condition to fail the stress test. While a negative treatment effect will cause support relative to opposition to decrease, it may not be sufficient to cause the number of people supporting the odd-even policy to be less than the number who oppose it. Therefore, we only present stress test estimates for cases where we find negative treatment effects.

To estimate the proportion of individuals who support or oppose the odd-even policy we use a Bayesian ordered logit. The ordered logit allows us to estimate which category of support/opposition is most likely for a given individual in a straightforward manner. We estimate this using a Bayesian approach as this allows us to easily present the uncertainty in the proportion we expect to support the policy compared to those expected to oppose the policy. Such uncertainty is important as it allows us to make probabilistic statements about whether the policy passes a given stress test or not.

5. Results

We begin with a general discussion of support levels for the odd-even policy, which speaks to Hypotheses 1 and 2, and then present the results aimed at Hypotheses 3-5, our policy stress test. Figure 4, panel on the upper and lower left, shows that a majority of respondents support the introduction of an odd-even policy, similar to the one introduced in New Delhi, with 68% in the control group and 67% in treatment groups combined "supporting" or "strongly supporting" it (N=2182). We also find that differences between men and women, the groups which characterized the main exemption in the previous implementation of the policy, in the control group are rather small, although women express strong support more often. This finding lends strong support for Hypothesis 1.

Insert Figure 4 here

Next we examine how this baseline support changes when all respondents are informed of ancillary benefits of the policy. As outlined in Hypotheses 2a and 2b, emphasis on how the odd-even rule could help global climate change mitigation efforts or improve India's global standing may bolster support for the policy.

Figure 5 displays the results relevant to this hypothesis. We can see that emphasizing the international benefits of the odd-even policy, whether it be in reducing emissions or increasing India's global leadership, does not lead to a significant increase in support for the odd-even policy. This is the case both on average and when looking at the groups we have examined previously relating to policy exemptions.

Insert Figure 5 here

We now turn to examining Hypotheses 3a and 3b, how exemptions impact the level of support for the odd-even rule. As shown in Figure 6, while information about exemptions can lead to a decrease in support for the odd-even policy, it is dependent on the type of exemption. Examining the average treatment effects, respondents who receive information that the odd-even policy would exempt women are significantly less likely to support the policy (Hypothesis 3a). In contrast, there is no significant negative effective for exempting two-wheelers (Hypothesis 3b). This result suggests that individuals are sensitive to the form of exemption. While debates on sexual harassment are continuing at high levels of intensity, it seems that study participants, on average, do not believe that exemptions granted to women are fair. Yet, they do not seem to react negatively to exemptions granted to two wheelers. While we do not have any direct evidence to explain this divergence, we offer two speculations. Arguably, two wheelers are viewed as vehicles for the less economically privileged and therefore worthy of exemptions. Second, because of the small size of two-wheelers, they are not viewed as major contributors to pollution.

Insert Figure 6 here

We also examine how the effect of including exemptions changes dependent on whether an individual is in the exempted group or not. In the case of the exemption of women from the odd-even policy, we can see that the negative effect of this exemption is driven by those individuals

who would not be exempted by the policy, men. In contrast, the exemption neither significantly decreases nor increases women's support for the odd-even policy. [22]

We now turn to Hypothesis 4, which deals with heterogeneity in the effect of exemptions within the two subgroups of the non-exempted. In this case, we are restricted to examining only the women exempted condition, as there are too few two-wheeler owners in the sample to reliably estimate such conditional effects and our sample does not include people not owning a car but owning a two-wheeler. As outlined previously we expect that non-exempted individuals may tolerate exemptions in some circumstances, dependent upon their personal situation. Figure 7 displays how the effect of including a female exemption varies dependent upon individuals' perceptions of air quality, whether there are asthma sufferers within the family, and the extent of their car use.

Insert Figure 7 here

In general, we find some evidence that these information inputs moderate the impact of female exemptions amongst the non-exempted. For air quality and asthma cases, we find that the negative effect of exemptions is strongest when these individuals believe air quality is good and when there are no asthma cases in their family. This is surprising because individuals do not have intrinsic interests in reducing air pollution and yet they are reasoning negatively about exemptions for women. Nevertheless, it should be noted that while the negative effect is statistically significant when individuals believe air quality is good and when there are no asthma

[22] We do not have data on the overlap between the ownership of cars and two-wheelers. Hence we cannot compare the effect of two-wheeler exemptions on policy support between exempted and non-exempted groups.

cases, this effect is not statistically significantly different compared to when individuals believe air quality is bad and with asthma cases respectively (Gelman and Stern 2012). Therefore, this provides partial support for the hypothesis that there is heterogeneity amongst the exempted. The negative effect of a female exemption is constant across all levels of car use, suggesting no moderating effect.

Figure 8 displays the results for Hypothesis 5a. In general, we see that these results are consistent with those found when examining Hypothesis 3. Support for the odd-even policy is significantly reduced when respondents are told that women will be exempted, with this effect being driven by those who are not exempted (men), while no such effect is found for the case of two-wheelers. Importantly, we can see that these effects do not significantly change for respondents who received information stating that these exemptions would reduce the effectiveness of the proposed policies. This lends further credence to the idea that respondents react negatively to exemptions when they are considered as unfair, rather than as a response to the potential impact upon the outcome of the policy. Thus, it is the perception of fairness, instead of perceptions about policy efficacy that are driving reductions in support for the policy.

Insert Figure 8 here

Figure 9 addresses Hypothesis 5b, which extends Hypothesis 4 to assess the increased policy stress by providing information that female exemptions reduce effectiveness. The results generally match those shown in Figure 7, as can be seen by the overlapping confidence intervals, this difference is not significant.

Insert Figure 9 here

Finally, we estimate our explicit measure for passing/failing the stress test: whether the erosion of support among the non-exempted is sufficient to tip the majority vote against the policy.

Insert Figure 10 here

Figure 10 displays the results of the stress test for information on female exemption. We can see that female exemptions, particularly when combined with information that it would reduce policy effectiveness, causes a decrease in the ratio of individuals supporting to those opposing the odd-even policy amongst those who would not be exempt (males). However, in spite of the negative treatment effects for female exemptions amongst the non-exempted (males), this negative effect is not sufficient to cause the ratio of people supporting to opposing the odd-even policy to be less than 1, which would have constituted a failure of the stress test.

Figure 11 displays the results of the stress test among the two subgroups among the non-exempted males. We present the results for perceptions of air quality and asthma cases within a family, as these moderators led to the significant negative treatment effects necessary for the policy to possibly fail the stress test. In this case we can see that in some circumstances the odd-even policy fails the stress test. For both treatments, the stress test is failed when looking at individuals who believe that air quality in Bangalore is very good or good. This is also the case for those who have no asthma cases in their family when receiving the exemptions treatment that primes respondents about its negative effect upon effectiveness.

However, if we look at the broader picture, we can see that as a whole the odd-even policy still manages to pass the stress test. In our sample, very few people perceive the air quality as good or state that there are no asthma cases in their family. Thus, if we weight the results of

these stress tests by the proportion of individuals in each sub-group (as displayed by the black line distribution), we can see that the odd-even policy still passes on the aggregate.

Insert Figure 11 here

In summary, we find that support for the odd-even policy in Bangalore is robust. While exemptions for two-wheelers do not lead to a significant decline in support, we find that exemptions for women significantly decrease support, primarily driven by those who would not be exempted (men). This difference in support between the exempted and non-exempted suggests that individuals are sensitive to "fairness" concerns. Conversely, exempting two-wheelers may be seen as legitimate and fair as they have lower emissions than automobiles and tend to be owned and used by less affluent parts of society.

As an extension to our focus on explaining general policy support, we also asked respondents about their willingness to financially support policy implementation. While an individual might be willing to offer political support for the odd-even rule, s/he might not be willing to pay personally for its enforcement because s/he thinks it is the government's job to do so. We were curious to assess whether policy support would erode when respondents were asked to financially support the implementation of the policy. This might be important with a view to the case of New Delhi because a substantive part of the enforcement work may have to be done by volunteers along with the traffic police. For instance, volunteers could approach cars at traffic lights if they were driving on wrong days. They could tell them that they are breaking the law and hand them a pamphlet about pollution. We therefore asked: "Making sure that car drivers follow the odd-even rule is a challenge. Would you be willing to donate 500/1000 Rs {value

randomly assigned} to pay for food and other facilities for volunteers to help enforce the odd-even rule in Bangalore?" Respondents could then select one of three response categories: yes, perhaps, or no.

The results, which are displayed in the online appendix, closely mirror those with regards to general support of the odd-even policy presented earlier. When faced with a costly choice (1000Rs) to help the odd-even policy, support is lower and female exemptions have a significant negative effect, particularly amongst men. In contrast, we observe no significant negative effects of exemptions upon support for the 500R donation. These results further echo that exemptions unrelated to the policy goal of reducing pollution can significantly dampen both the support for the policy as well as the willingness to voluntarily contribute to its enforcement, thereby potentially weakening its effectiveness.

Conclusion

This paper proposes a policy stress test concept to examine how policy exemptions influence public support for a policy that imposes differentiated costs on the regulatees. It applies this concept to a particular empirical case to demonstrate its usefulness. The stress test seeks to assess the robustness of policy support when regulatees are provided with different levels of negative information about the policy, especially the exemptions it provides and how such exemptions influence policy efficacy.

The empirical analysis suggests that general support for introducing the odd-even rule in Bangalore is surprisingly high and robust, particularly in view of the fact that our sample focuses on car owners who face high opportunity costs from rather severe restrictions on using their personal vehicles. We thus think that support for the odd-even rule among the non-car owning

mass public is likely to be even higher, because of lower opportunity costs. Even though car owners are likely to be politically more vocal and influential than other parts of the population, our finding suggests that it is politically feasible for policymakers to introduce the odd-even rule in Bangalore.

Our findings have broader relevance, both for research on regulation and governance, and for policy making. For academic research, we offer a framework for systematically examining the implications of one crucial aspect of environmental policy design (exemptions) for the political feasibility of policies, assuming that public acceptance is essential to effective problem solving. Application of our framework to urban air pollution problems in other areas of India and other countries, and to other environmental policy areas where exemptions are being used or considered is straightforward and relevant. While there is a significant amount of research on public acceptance of road space rationing in general (Wang et al., 2014; Liu et al., 2016; Jia et al., 2017), this is among the first papers to use an experimental approach for assessing the implications of exemptions for policy support.

For policy-making, we offer an approach for assessing public support for environmental policy designs that include exemptions. In essence, such research can help anticipate problems that may result from trying to get a new policy adopted in the first place by granting exemptions, but then running into difficulties over reduced policy effectiveness and opposition by the non-exempted. We did not detect a substantial trade-off problem in this regard in the Bangalore odd-even rule case, which bodes well for attempts to implement this rule there, and also in other large cities of India.

References

Anand, Sudhir and Martin Ravallion (1993). Human development in poor countries: on the role of private incomes and public services. *The Journal of Economic Perspectives* 7(1): 133-150.

Bernauer, Thomas (2013). Climate change politics. *Annual Review of Political Science* 16: 421-448.

Bernauer, Thomas, and Vally Koubi. (2009). Effects of political institutions on air quality. *Ecological Economics* 68 (5): 1355-1365.

Bonsall, P., & Young, W. (2010). Is there a case for replacing parking charges by road user charges?. *Transport Policy*, *17*(5), 323-334.

Caffera, M., 2011. The use of economic instruments for pollution control in Latin America:lessons for future policy design. *Environment and Development Economics,* 16, 247-273.

Calthrop, E., & Proost, S. (1998). Road transport externalities. *Environmental and Resource Economics*, *11*(3-4), 335.

Cao, X., & Prakash, A. (2010). Trade competition and domestic pollution: A panel study, 1980–2003. *International Organization*, *64*(03), 481-503.

Chandra, B. P.; Sinha, V.; Hakkim, H.; Kumar, A.; Pawar, H.; Mishra, A. K.; Sharma, G.; Pallavi; Garg, S.; Ghude, Sachin D.; Chate, D. M.; Pithani, Prakash; Kulkarni, Rachana; Jenamani, R. K.; Rajeevan, M. 2018. Odd--even traffic rule implementation during winter 2016 in Delhi did not reduce traffic emissions of VOCs, carbon dioxide, methane and carbon monoxide. *Current Science,* 114(6): 1318-1325.

Chidambaram, B., Janssen, M. A., Rommel, J., & Zikos, D. (2014). Commuters' mode choice as a coordination problem: A framed field experiment on traffic policy in Hyderabad, India. *Transportation Research part A: Policy and Practice*, *65*, 9-22.

Chen, Y., Jin, G. Z., Kumar, N., & Shi, G. (2013). The promise of Beijing: Evaluating the impact of the 2008 Olympic Games on air quality. *Journal of Environmental Economics and Management*, *66*(3), 424-443.

Chin, Anthony, and Peter Smith (1997) Automobile ownership and government policy: The economics of Singapore's vehicle quota scheme. *Transportation Research Part A: Policy and Practice* 31(2): 129-140.

Cramton, P., and Kerr, S. (2002). Tradeable carbon permit auctions: How and why to auction not grandfather. *Energy Policy*, *30*(4), 333-345.

Dahlgren, J. (1998). High occupancy vehicle lanes: Not always more effective than general purpose lanes. *Transportation Research Part A: Policy and Practice*, *32*(2), 99-114.

Davis, L. (2008) The effect of driving restrictions on air quality in Mexico City. *Journal of Political Economy*. 116, 38-81.

de Grange, L., & Troncoso, R. (2011). Impacts of vehicle restrictions on urban transport flows: the case of Santiago, Chile. *Transport Policy*, *18*(6), 862-869.

Dolsak, Nives and Aseem Prakash. (2015) Confronting the "China Excuse": The Political Logic of Climate Change Adaptation. *Solutions*, 6(4): 27-29.

Eastin, Joshua and Aseem Prakash (2013) Economic Development and Gender Equality: Is there a Gender Kuznets Curve? *World Politics*, 65(1): 156-184.

Eskeland, G., Feyzioglu, T. (1997) Rationing can backfire: the "day without a car" in Mexico City. *World Bank Economic Review*, 11, 383-408.

Evans, A. W. (1992). Road congestion pricing: when is it a good policy?. *Journal of Transport Economics and Policy*, 213-243.

Gabel, M. J. (1998). Economic integration and mass politics: Market liberalization and public attitudes in the European Union. *American Journal of Political Science*, 936-953.

Gallego, F., Montero, J.-P., Salas C (2013). The effect of transport policies on car use: evidence from Latin American cities *Journal of Public Economy*. 107, 47-62.

Gelman, A., and H. Stern (2012) The Difference Between "Significant" and "Not Significant" is not Itself Statistically Significant, The American Statistician, 60:4, 328-331, DOI: 10.1198/000313006X152649

Ghude, S. D., D. M. Chate, C. Jena, G. Beig, R. Kumar, M. C. Barth, G. G. Pfister, S. Fadnavis, and P. Pithani (2016). Premature mortality in India due to PM2.5 and ozone exposure, *Geophysical Research Letter*, 43, 4650–4658.

Goel, R., Guttikunda, S. K., Mohan, D., & Tiwari, G. (2015). Benchmarking vehicle and passenger travel characteristics in Delhi for on-road emissions analysis. *Travel Behaviour and Society*, *2*(2), 88-101.

Goyal, P., and Geetika Gandhi. (2016) Assessment of Air Quality during the 'Odd-Even Scheme'of Vehicles in Delhi. *Indian Journal of Science and Technology* 9.48 (2016).

Gibson, J. L., Caldeira, G. A., & Spence, L. K. (2005). Why do people accept public policies they oppose? Testing legitimacy theory with a survey-based experiment. *Political Research Quarterly*, *58*(2), 187-201

Giuliano, G. (1992). An assessment of the political acceptability of congestion pricing. *Transportation*, *19*(4), 335-358.

Grant, W. J., Moon, B., & Busby Grant, J. (2010). Digital dialogue? Australian politicians' use of the social network tool Twitter. *Australian Journal of Political Science*, *45*(4), 579-604.

Han, D., Yang, H., & Wang, X. (2010). Efficiency of the plate-number-based traffic rationing in general networks. *Transportation Research Part E: Logistics and Transportation Review*, 46(6), 1095-1110.

Harding, Garrett. 1968. The Tragedy of the Commons. *Science*, December, 1243-1248.

Holguín-Veras, J., Polimeni, J., Cruz, B., Xu, N., List, G., Nordstrom, J., & Haddock, J. (2005). Off-peak freight deliveries: Challenges and stakeholders' perceptions. *Transportation Research Record: Journal of the Transportation Research Boar*d, , 42-48.

Jia, N., Zhang, Y., He, Z., Li, G. (2017) Commuters' acceptance of and behavior reactions to license plate restriction policy: A case study of Tianjin, China. *Transport Research. Part D Transport and Environment*. 52, 428–440.

Kitschelt, Herbert. 2000. Linkages between citizens and politicians in democratic polities. *Comparative Political Studies* 33(6-7): 845-879.

Kutzbach, M. (2010). Megacities and megatraffic. *ACCESS Magazine*, 37(Fall):31-35.

Liu, Y., Hong, Z., Liu, Y. (2016) Do driving restriction policies effectively motivate commuters to use public transportation*? Energy Policy* 90, 253–261.

McGrath, L.F., Bernauer, T. (2017) How strong is public support for unilateral climate policy and what drives it?: Public support for unilateral climate policy. *Wiley Interdisciplinary. Review Climate Change* 484.

Mettler, S., & Soss, J. (2004). The consequences of public policy for democratic citizenship: Bridging policy studies and mass politics. *Perspectives on Politics*, 2(1), 55-73.

Mohan, Dinesh, Geetam Tiwari, Rahul Goel, and Paranjyoti Lakhar. 20:17. Evaluation of the Odd-Even Day Traffic Restriction Experiments in Delhi, India. No. 17-04218. 2017.

Ostrom, Elinor (1990). *Governing the Commons*. Cambridge University Press.

Olson, Mancur. (1965). *The Logic of Collective Action*. Harvard University Press.

Pavani, V. Sree, and A. Ramachandra Aryasri. (2016) Pollution Control Through Odd-Even Rule: A Case Study of Delhi. *Indian Journal of Science* 23: 403-411.

Regidor, J. R. F. (2013). Traffic Congestion in Metro Manila: Is the UVVRP Still Effective?. *Philippine Engineering Journal,* 34(1).

Schuitema, G., Steg, L., Forward, S. (2010) Explaining differences in acceptability before and acceptance after the implementation of a congestion charge in Stockholm. *Transport Research Part A: Policy Practice*. 44, 99–109.

Tyler, T. R. (2006). *Why People Obey the Law*. Princeton University Press.

Wang, L., Xu, J., Qin, P., 2014. Will a driving restriction policy reduce car trips?—The case study of Beijing, China. *Transport Research Part A: Policy and Practice*. 67, 279–290.

Vogel, D. (1990). When consumers oppose consumer protection: The politics of regulatory backlash. Journal of Public Policy, 10(4), 449-470.

Figure 1: A Stress Test for Assessing Policy Support

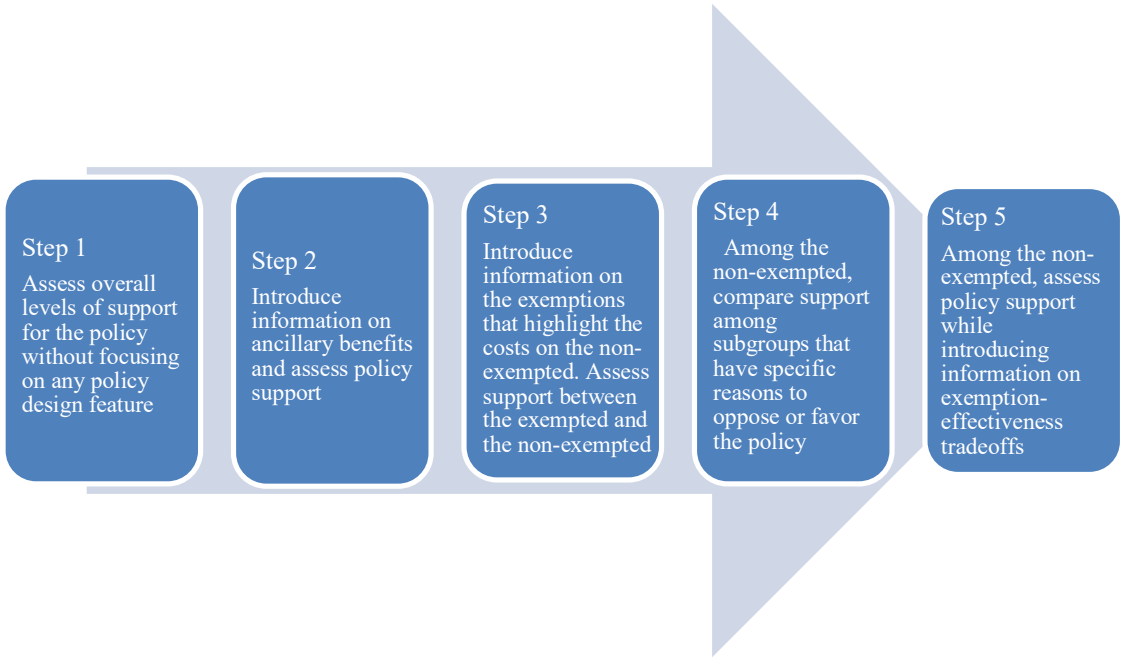


Figure 2: Information on the Odd-Even Rule, Given to all Survey Participants

Now please read the following information:

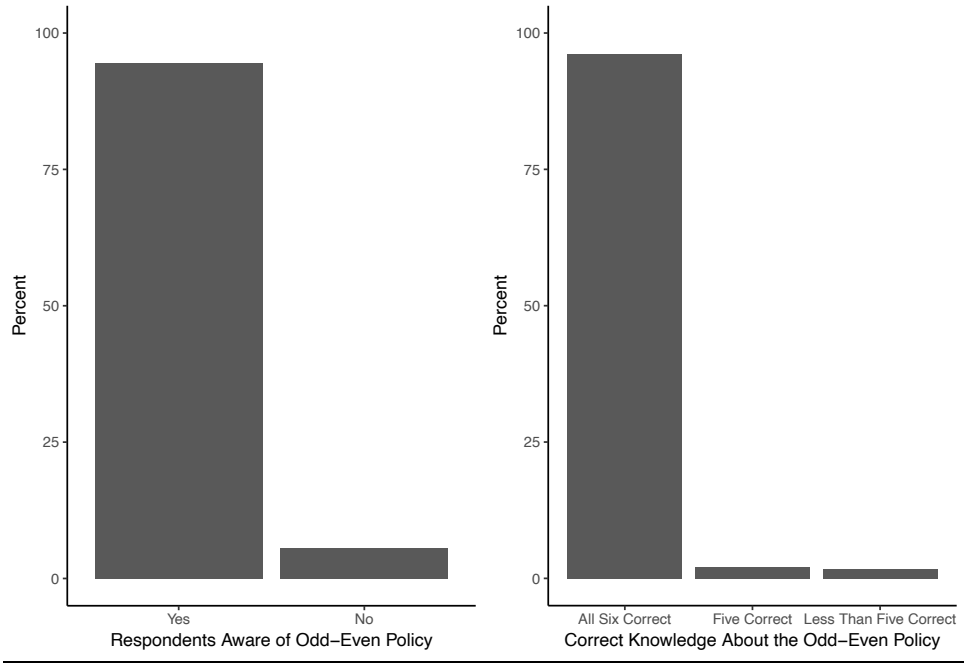
Air pollution in many cities of India is among the worst in the world. In 2016, the government of New Delhi tried out a new policy to reduce air pollution by limiting the use of private cars. New Delhi and other cities around India are now considering whether or not to implement such a policy on a permanent basis.

The main part of the new policy is the so-called "odd-even rule" for private cars. On Mondays, Wednesdays, and Fridays only those cars with even-numbered license plates (those ending with 0, 2, 4, 6, 8) are allowed to drive in Delhi. On Tuesday, Thursday, and Saturday, only those cars with odd-numbered license plates (those ending with 1, 3, 5, 7, 9) are allowed to drive. There are no driving restrictions on Sunday.Please take a moment to look at the following picture, which illustrates how the odd-even policy works.

This means that car owners can use their car only every other day, which means three out of six days of the working week. On those other three days of the working week when they cannot use their car, they need to find alternative ways to get to office, drive children to school, visit friends and relatives, and go to the market.

Enforcing traffic policy is an important part of this new rule. Along with Delhi Police, the government organized a large number of volunteers to make sure car owners comply with this policy. These volunteers stand at major traffic intersections, approach cars on traffic lights if they are driving on wrong days. They politely tell them that they are breaking the law and hand them a pamphlet about pollution and the new rule.

Figure 3: Prior to Treatment Knowledge of Odd-Even Policy



Note: the item used for the graph on the right side listed six statements on what the odd-even policy does. Some statements were accurate, some not. The figure shows that the large majority gave correct answers as to whether a statement was accurate or not.

Figure 4: The distribution of support for the odd-even rule, dependent on whether the individual is in a treatment condition or not, and also by their sex.

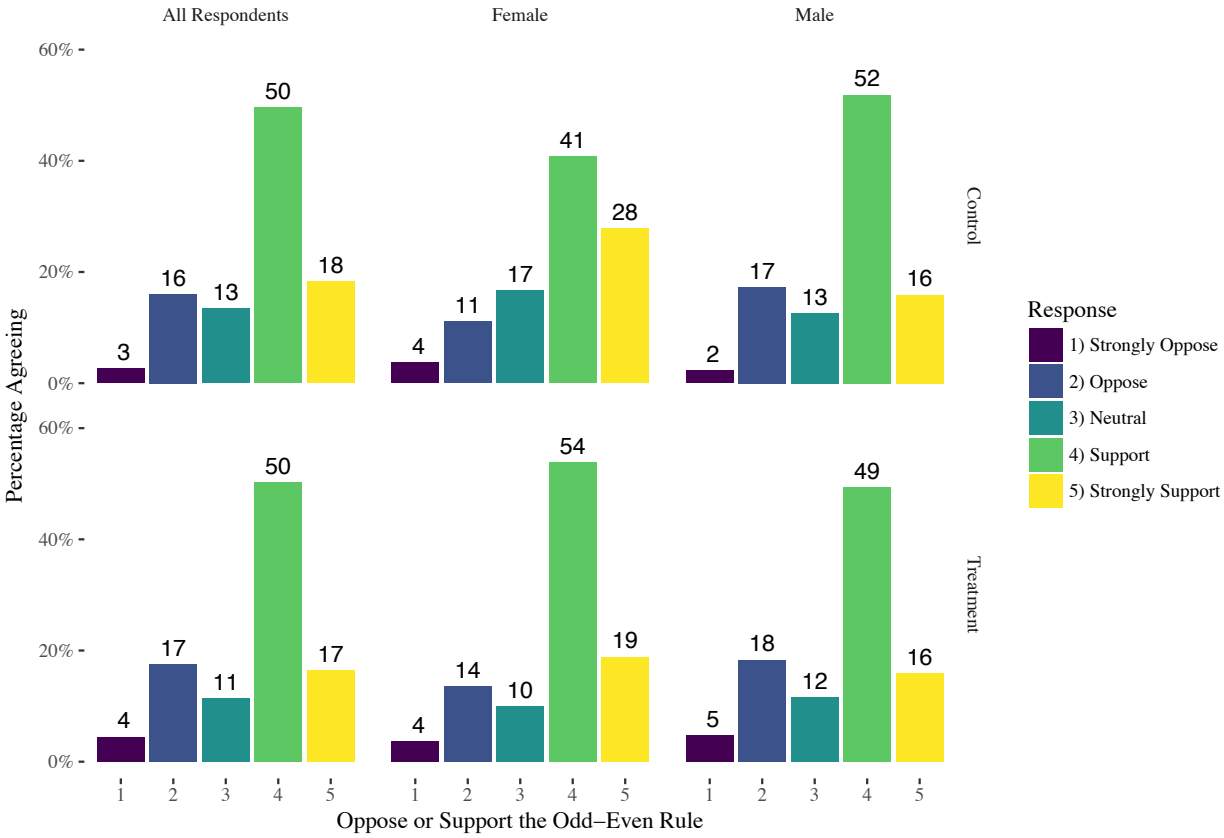


Figure 5: The effect of framing upon support for the odd-even policy. Each panel displays the treatment effect for the relevant emphasis frame, that is the difference in the average level of support for the odd-even policy comparing those who receive information about international efforts or leadership compared to those who do not. Both the average treatment effect and treatment effects conditional upon exemption status are shown. Lines indicate 95% confidence intervals. Results from models with and without covariate adjustment are both displayed.

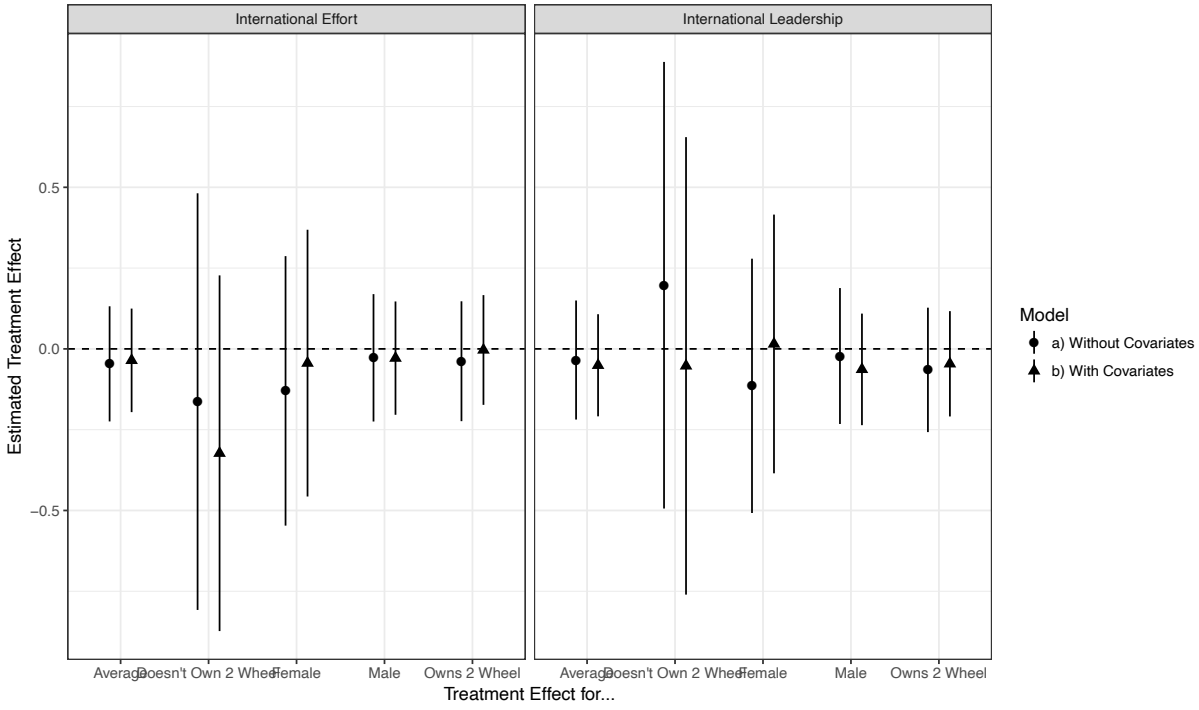
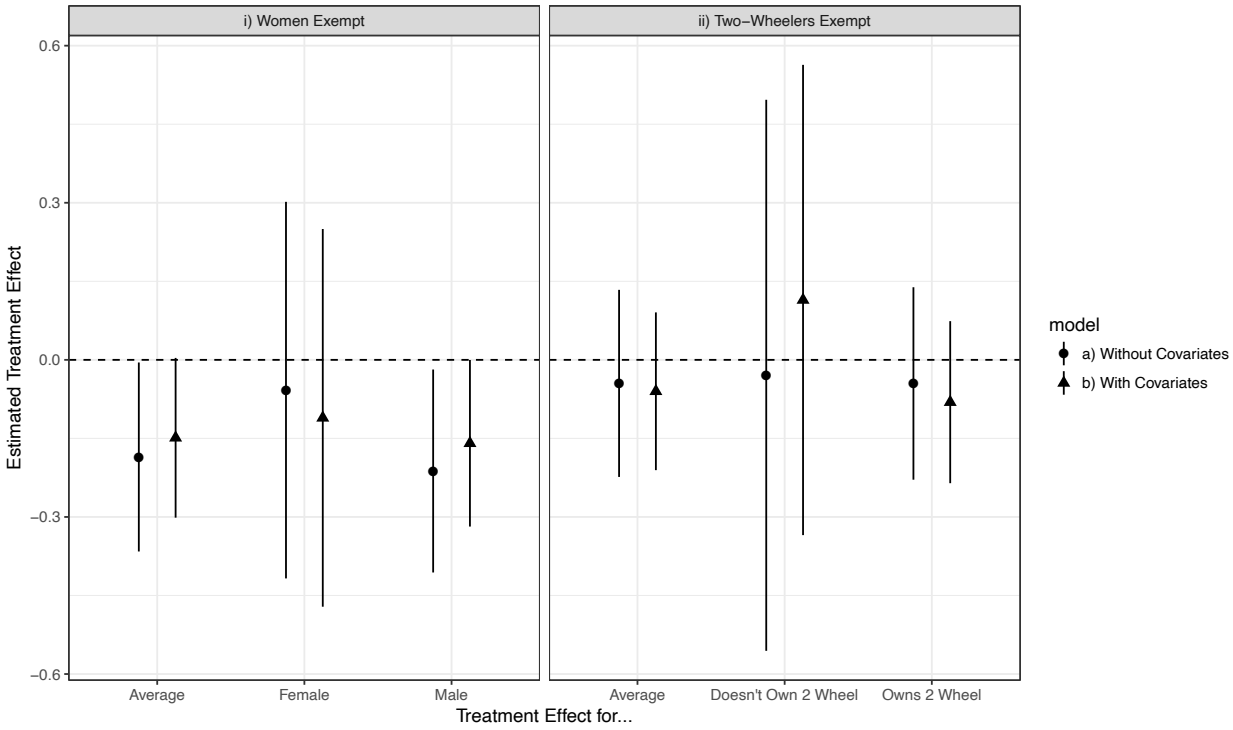


Figure 6: The effect of policy exemptions upon support for the odd-even policy. Each panel displays the treatment effect for the relevant exemption, that is the difference in the average level of support for the odd-even policy comparing those who receive information about an exemption compared to those who do not. Both the average treatment effect and treatment effects conditional upon exemption status are shown. Lines indicate 95% confidence intervals. Results from models with and without covariate adjustment are both displayed.



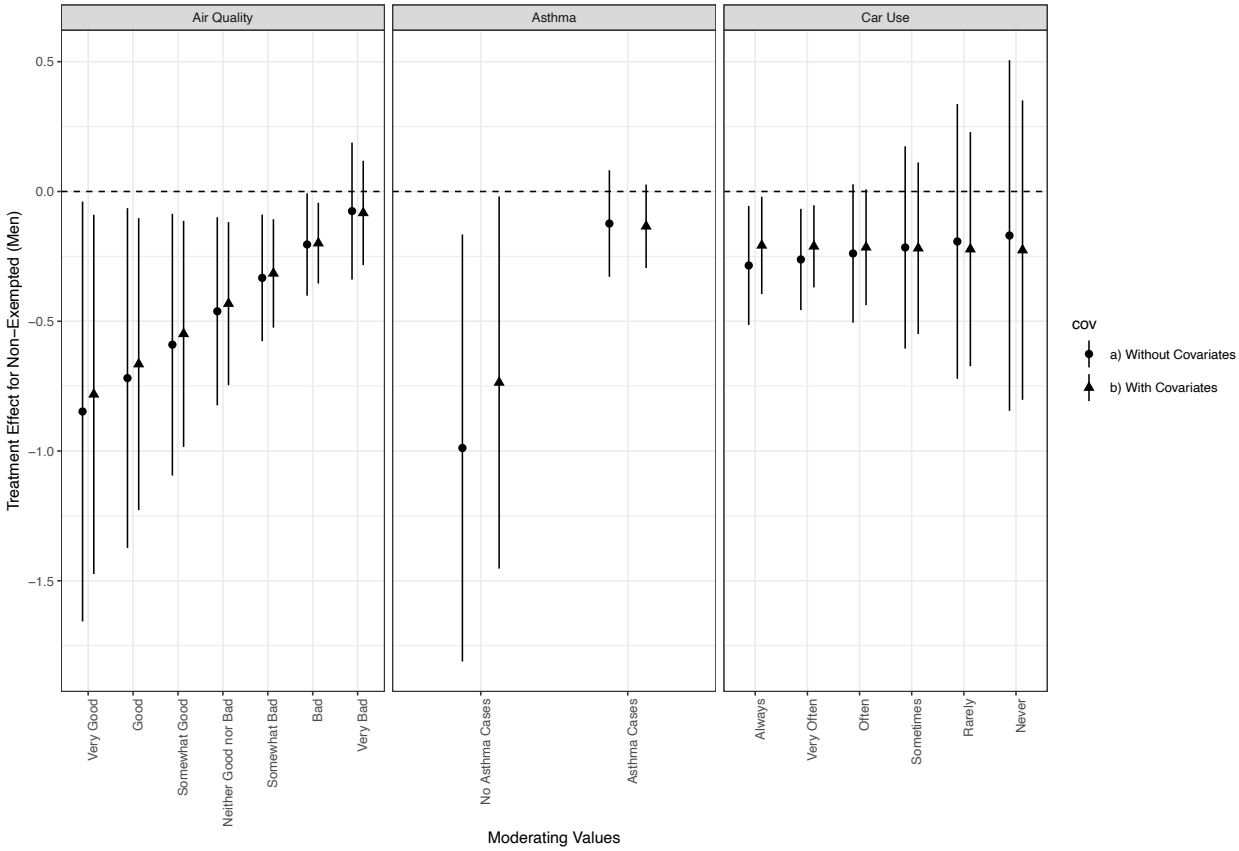


Figure 7: *How exempting females affects support for the odd-even policy amongst the non-exempted (males), conditional upon perceptions about air quality, family asthma prevalence, and car usage. Lines indicate 95% confidence intervals. Results from models with and without covariate adjustment are both displayed*

Figure 8: How the effect of policy exemptions upon support for the odd-even policy changes when given information about how exemptions harm efficacy. Each panel displays the treatment effect for the relevant exemption, that is the difference in the average level of support for the odd-even policy comparing those who receive information about an exemption compared to those who do not. Both the average treatment effect and treatment effects conditional upon exemption status are shown. Lines indicate 95% confidence intervals. Dark points and lines display the treatment effect for information about exemptions without efficacy information, while light points and lines display the treatment effects including the additional efficacy information. Results from models with and without covariate adjustment are both displayed.

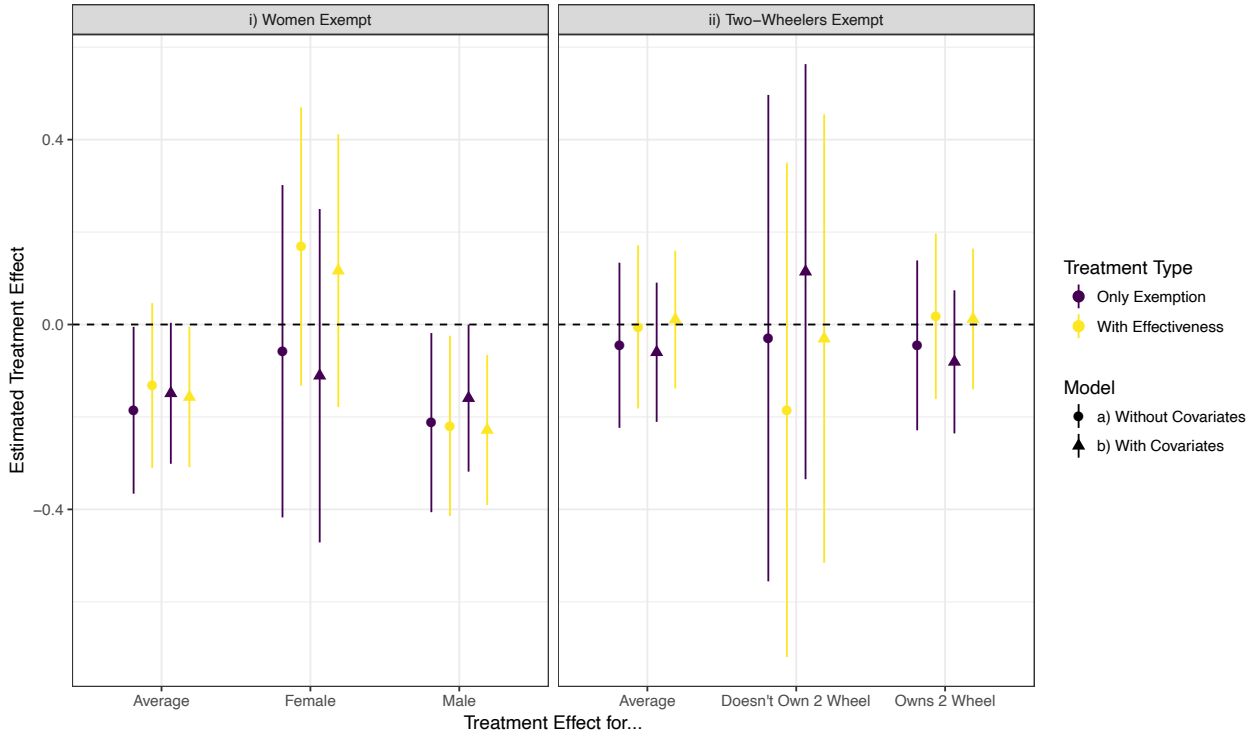


Figure 9: How exempting females and information about how this impacts policy efficacy affects support for the odd-even policy amongst the non-exempted (males), conditional upon perceptions about air quality, family asthma prevalence, and car usage. Lines indicate 95% confidence intervals. Dark points and lines display the treatment effect for information about exemptions without efficacy information, while light points and lines display the treatment effects including the additional efficacy information. Results from models with and without covariate adjustment are both displayed.

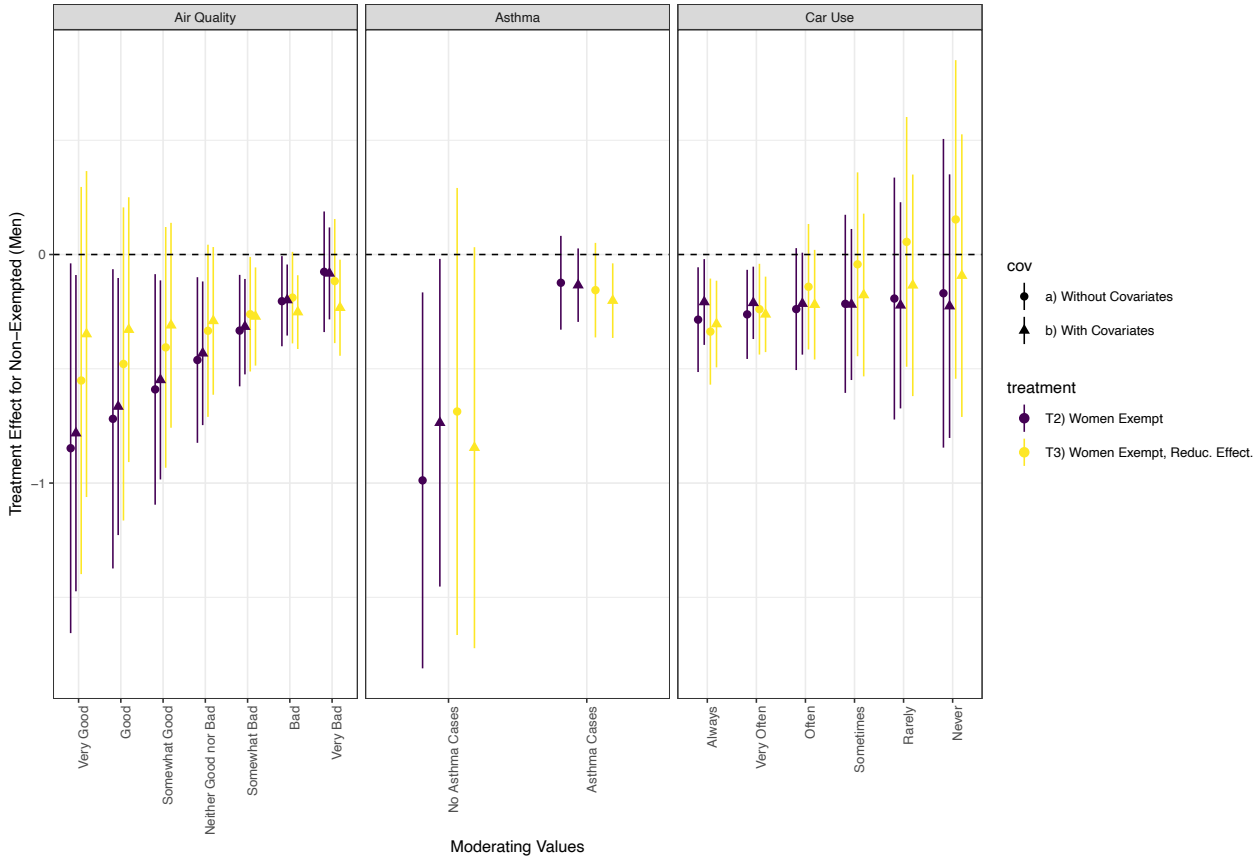


Figure 10: Results from the stress test for exemptions. The distributions show the posterior distribution of the ratio of support to opposition for the odd-even policy. The dark shaded distributions show the ratio for those who would be exempt in a given treatment, while the light shaded distributions show the ratio for those who would not be exempt. The distribution indicated by a black line is the ratio ignoring exemption status (i.e. the average of the exempt and non-exempt ratios, weighted by the proportion of exempt/non-exempt in the sample). The vertical dashed line indicates the value of 1, the point where support and opposition are equal. Values larger than 1 indicate higher support than opposition, with values less than 1 indicating the opposite.

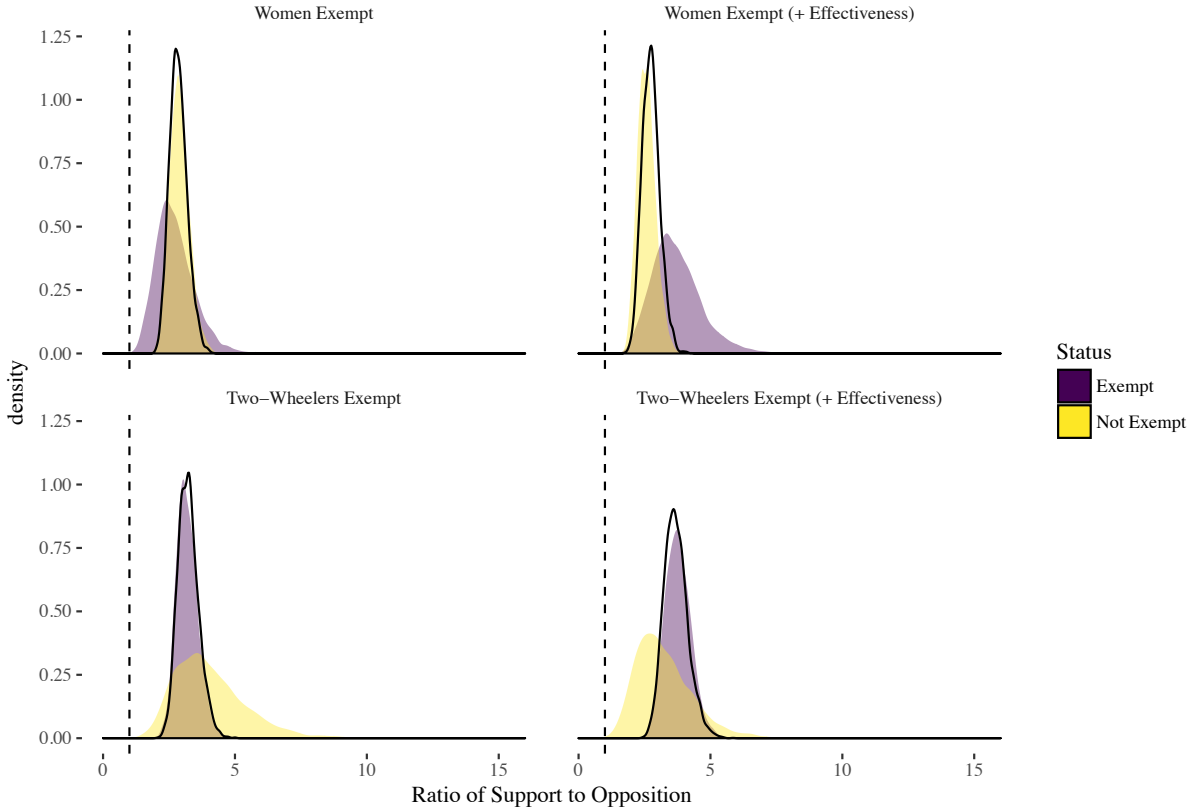


Figure 11: : Results from the stress test for males in the case of female exemptions, allowing for heterogeneity based upon car usage, perceptions of air pollution, and family asthma prevalence.. The distributions show the posterior distribution of the ratio of support to opposition for the odd-even policy. The shaded distributions correspond to the stress test results by sub-group, with colour indicating a particular sub-group. The distribution indicated by a black line is the ratio ignoring exemption status (i.e. the average of the ratios by sub-group, weighted by the proportion of exempt/non-exempt in the sample). The vertical dashed line indicates the value of 1, the point where support and opposition are equal. Values larger than 1 indicate higher support than opposition, with values less than 1 indicating the opposite.

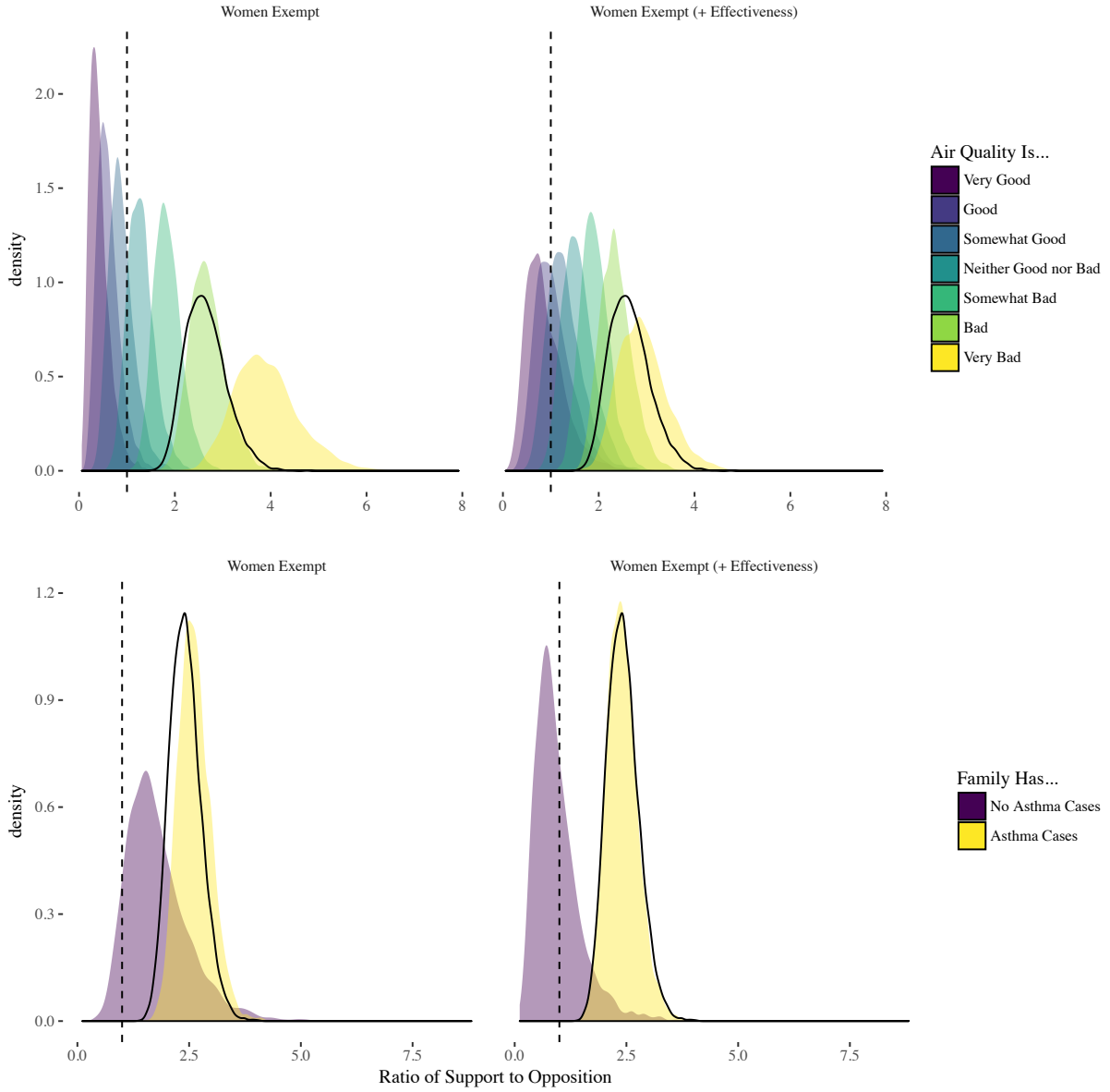


Table 1: Treatment Conditions

		Group	*Information*
Control		Control (placebo) group	See above
T1	Hypotheses 1	Effectiveness	Odd-even policy has reduced air pollution by up to 20 percent
T2	Hypothesis 2a	Ancillary benefits	Information that odd-even policy reduces not only local air pollution, but also contributes to international efforts against global warming.
T3	Hypothesis 2b	Climate benefits, India's leadership	Similar to above, but emphasis on demonstrating India's leadership in international efforts against global warming.
T4	Hypothesis 3a	Exemption for women	Women are exempt from the odd-even policy because of sexual harassment risk and difficulties in finding alternative transportation.
T5	Hypothesis 3b	Exemption for two-wheelers	Two-wheelers are exempt from the off-even policy because their users tend to have lower incomes and fewer alternatives to commute.
	Hypothesis 4	Focus on two subgroups within non-exempted male car owners (sub group analysis and not a different treatment frame)	
T6	Hypothesis 5a	Exemption for women, reduced effectiveness	Same information as above, plus: information that this reduces air pollution by only 10 instead of 20 percent.
T7	Hypothesis 5b	Exemption for two-wheelers, reduced effectiveness	Same information as above, plus: information that this reduces air pollution by only 10 instead of 20 percent.